**THE OSIRIS-REx CONTAMINATION CONTROL AND WITNESS STRATEGY.** J.P. Dworkin[1*], L. Adelman[1], T.M. Ajluni[1], A.V. Andronikov[2], D.M. Ballou[3], A.E. Bartels[1], E. Beshore[2], E.B. Bierhaus[4], W.V. Boynton[2], J.R. Brucato[5], M.P. Callahan[1], B.C. Clark[7], H.C. Connolly Jr.[8], J.E. Elsila[1], H. L. Enos[2], D.F. Everett[1], I.A. Franchi[9], J.S. Fust[3], D.P. Glavin[1], J.E. Hendershot[1], J.W. Harris[4], A.R. Hildebrand[10], G. Jayne[1], R.W. Jenkens[1], W.E. Kretsch[4], R.M. Kuhns[4], D.S. Lauretta[2], J.V. Ladewig[4], C.C. Lorentson[1], J.R. Marshall[11], L.L. Matthias[12], H.L. McLain[1], S.R. Messenger[6], R.G. Mink[1], J. Moore[4], K. Nakamura-Messenger[6], J.A. Nuth III[1], C.A. Reigle[4], K. Righter[6], B. Rizk[2], W.D. Roher[1], J.F. Russell[4], S.A. Sandford[13], J.P. Schepis[1], M.F. Sovinski[1], J.M. Vellinga[4,14] and M.S. Walker[1] [1]NASA GSFC, [2]University of Arizona, [3]United Launch Alliance, [4]Lockheed Martin, [5]INAF, [6]NASA JSC, [7]SSI, [8]CUNY/AMNH, [9]Open University, [10]University of Calgary, [11]SETI Institute, [12]NASA KSC, [13]NASA ARC, [14]Retired, *Jason.P.Dworkin@nasa.gov

**OSIRIS-REx:** The OSIRIS-REx mission (Origins, Spectral Interpretation, Resource Identification, and Security Regolith Explorer) is the third NASA New Frontiers mission. It is scheduled for launch in 2016. The primary objective of the mission is to return at least 60 g of "pristine" material from the B-type near-Earth asteroid (101955) Bennu, which is spectrally similar to organic-rich CI or CM meteorites [1]. The study of these samples will advance our understanding of materials available for the origin of life on Earth or elsewhere. The spacecraft will rendezvous with Bennu in 2018 and spend at least a year characterizing the asteroid before executing a maneuver to recover a sample of regolith in the touch-and-go sample acquisition mechanism (TAGSAM). The TAGSAM and sample is stowed in the sample return capsule (SRC) and returned to Earth in 2023.

**Defining Pristine:** The OSIRIS-REx mission has a level-1 requirement to return the regolith sample in a "pristine" state. We define pristine to mean that no foreign material was introduced to the sample in an amount that hampers our ability to analyze the chemistry and mineralogy of the sample [2]. Though challenging, adequate knowledge of the nature of contaminants can effectively mitigate the impact of the contamination, depending on the analysis.

**Contamination Control:** Based on our definition of pristine, we derived level-2 requirements for contamination control that were 1) traceable to an independent document or analysis, 2) achievable in the project budget and schedule, and 3) rapidly verifiable without impacting the critical path during Assembly, Test, and Launch Operations (ATLO).

Based on a series of logical arguments [2] all contamination control requirements were condensed to a 180 ng/cm$^2$ amino acid requirement (based on Stardust performance), IEST-STD-CC1246D 100A/2 requirement, and limiting free hydrazine deposited on the sampler to 180 ng/cm$^2$. Since verification or mitigation is impossible after launch, all subsequent contamination information is obtained via witness plates.

**Witness Plates:** Witness plates are passive materials that are exposed to the contamination environment and analyzed in a laboratory. The simplest scenario would be to fly a single passive witness plate. However, witness plates cannot establish the direction of molecular flow. This means that it would be impossible to determine if a compound found on a witness which was exposed to both the sample and the spacecraft is extraterrestrial, contamination, or both. For a witness to be scientifically useful, it must have the same history as the sample collector, with the exception of the sample. This means that the witnesses must be physically close to the sample, but cannot be contaminated by the sample. For OSIRIS-REx, the sample is exposed to two different environments: (i) TAGSAM contamination from the launch container prior to collection; and (ii) contamination acquired after collection, when TAGSAM is exposed to the spacecraft and the inside of the SRC.

If asteroid material outgases into a witness or sheds dust onto it, it may be difficult to determine if the analyte on the witness is sample or contamination. Thus, it is necessary to have the ability to protect the witness from the sample with a physical barrier. The science team will have the ability to assemble the contamination history of the sample by comparing witness plates.

To minimize complexity, there are no dedicated witness plate cover motors; instead, required movements leverage other spacecraft actions. The lack of cover motors limits the flexibility of the witness to be exposed at the optimal time. This is mitigated by six pairs of aluminum and sapphire witness plates (Table 1). When compared against each other, the entire flight contamination history of the sample is revealed.

**Table 1. OSIRIS-REx flight witness plates**

| Location | Beginning of Exposure | End of Exposure |
|---|---|---|
| TAGSAM | TAGSAM integration | SRC disassembly and curation |
| TAGSAM | TAGSAM integration | TAGSAM deployment near Bennu |
| TAGSAM | TAGSAM stowage in SRC | SRC disassembly and curation |
| SRC | SRC integration | SRC disassembly and curation |
| SRC | SRC integration | Opening SRC for TAGSAM stowage |
| SRC | Opening SRC for TAGSAM stowage | SRC disassembly and curation |

Note: To aid post-flight handling, witness plates are etched to identify exposed side and have unique thicknesses for each location.

**References:** [1] Clark et al. (2011) Icarus *216*, 462-475. [2] Dworkin et al. (2015) LPSC 1147.